INCH-POUND

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PERFORMANCE SPECIFICATION SHEET

# ELECTRON TUBE, IMAGE CONVERTER
# TYPE 6929

This specification is approved for use by all Departments and Agencies of the Department of Defense.

The requirements for acquiring the electron tube described herein shall consist of this document and the latest issue of MIL-PRF-1.

DESCRIPTION: Infrared sensitive (S1 photocathode surface; P20 phosphor image screen).

ABSOLUTE RATINGS:

| Parameter: | Eb | Light flux | ib 2/ | Ib | Rb | TA | Alt |
|---|---|---|---|---|---|---|---|
| Unit: | V dc | lumen | µA dc | µA dc | Meg | °C | ft |
| Maximum: | 12,000 | --- | 2.0 | 0.20 | --- | 68 | 10,000 |
| Minimum: | --- | --- | ---- | ---- | ---- | -54 | --- |
| Test condition: | 12,000 | 1/ | ---- | --- | 100 | 20 to 23 | --- |

See the footnotes at the end of table I.

GENERAL:

Qualification - Required.

Stabilization: 3/

Holding period: 4/

TABLE I. Testing and inspection.

| Inspection | Method | Conditions | Acceptance level | Inspection level or code | Symbol | Limits | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Min | Max | |
| Conformance inspection, part 1 | | | | | | | | |
| Shock | --- | 5/ 9/ | --- | --- | --- | --- | --- | --- |
| Irradiation surge | --- | 6/ | ---- | ---- | ---- | ---- | ---- | ---- |
| Conversion index | --- | 7/ | ---- | ---- | CI | 10 | ---- | ---- |
| Conversion index decay | --- | 4/ 21/ | ---- | ---- | ---- | ---- | ---- | ---- |
| Conversion index to background | --- | 8/ 21/ | ---- | ---- | CI/B | 3.0 | --- | --- |
| Alignment and image shift | --- | 9/ | ---- | ---- | ---- | ---- | ---- | ---- |
| Center resolution | --- | 10/ | --- | --- | Res | 50 | --- | 1-p/mm |
| Peripheral resolution | --- | 10/ | --- | --- | Res | 12 | --- | 1-p/mm |
| Center magnification | --- | 11/ | --- | --- | Cmx | 0.714 | 0.758 | --- |
| Distortion | --- | 12/ | --- | --- | --- | 6 | 10 | % |
| Cathode and screen spots | --- | 13/ 21/ | ---- | ---- | ---- | ---- | ---- | ---- |
| Breakdown | --- | 14/ 21/ | ---- | ---- | ---- | ---- | ---- | ---- |
| Dark current | --- | Light flux = 0 15/ 21/ | --- | --- | Llk | --- | 0.02 | µA |
| Conformance inspection, part 2 | | | | | | | | |
| Cathode and screen uniformity | --- | 16/ | 2.5 | I | --- | --- | --- | --- |
| Vibration (1) (cathode-ray tubes) | 5111 | 9/ 17/ 20/ | 1.0 | II | ---- | ---- | ---- | ---- |
| Vibration (2) (cathode-ray tubes) | 5111 | 9/ 18/ 20/ | 2.5 | S3 | ---- | ---- | ---- | ---- |
| Temperature cycling and thermal shock | --- | 9/ 19/ 20/ | 1.0 | II | ---- | ---- | ---- | ---- |
| Permanence of marking | 1105 | | --- | --- | ---- | ---- | ---- | ---- |

1/ Unless otherwise specified, the radiation source shall be a tungsten filament lamp operated at a color temperature of 2,854°K. A Corning No. 2540 filter (melt No. 1613, of .103 inch (2.61 mm) thickness), or equivalent, shall be placed between the radiation source and the photocathode. The quantity of radiation from the source incident on the photocathode for the individual tests shall be the amount stated in the note describing the particular test.

2/ The period of time of ib for any single period shall not exceed 2 minutes, and the tube shall not be subjected to more than 10 such periods during its life.

TABLE I. Testing and inspection - Continued.

3/ The tube shall be held for a manufacturer's stabilizing period of at least 2 weeks. Prior to this period, the temperature, vibration, and shock tests shall be made; at the end of the two-week period, the irradiation surge and initial conversion index tests shall be made in the order listed. (See 4/).

4/ After a holding period of 672 hours, which shall not include the manufacturer's stabilizing period of at least 336 hours, the conversion index of the tube shall be not less than 10, and shall not have slumped more than 20 percent from the initial value measured at the end of the stabilizing period. If the conversion index has slumped more than 20 percent, but still is above the minimum value of 10, the tube shall be held an additional 2 weeks. At the end of the 6-week period, the tube shall have a conversion index of not less than 10 and shall not have slumped more than 30 percent of the initial value.

5/ Upon completion of the vibration (1) test, specified herein, each tube, in a proper holder, shall be energized with 12,000 volts for a stabilization period of 15 seconds in a darkened room (not more than 0.01 footcandle). At the end of this period, with the tube still energized and no incident light on the photocathode, it shall be subjected to shock impacts in the following manner:

The shock impacts shall be applied in a way to generate nominal half-sine wave pulses having a minimum of 75 G's at the peak. The duration of each shock pulse shall be 6 ±2 milliseconds measured between the 10 percent values of the peak amplitude. The energy under the shock curve shall be not less than 0.25 G second and the after oscillations shall be not greater than 15 percent of the peak amplitude of the nominal half-sine wave pulse. The tube shall be subjected to six shock pulses parallel to, and six shock pulses perpendicular to, its longitudinal axis. Presence of flashing or electrical bursting during more than two shocks in each direction shall be cause for rejection.

6/ The image tube shall be subjected to an irradiation surge by exposing the photocathode to radiation from a tungsten light source (which need not be the one specified in 1/) for a period of at least 5.0 seconds to produce a minimum of 2.0 μA of photocathode current. The image of the source on the screen of the tube shall not disintegrate nor shall any part of the image darken or be blanked out during the irradiation surge.

7/ The radiation source, specified in 1/, shall be used to produce a circular image .500 inch (12.70 mm) in diameter on the center of the photocathode. The amount of incident flux on the photocathode (prior to interposing the filter) shall be 0.0100 ± 0.0005 lumen. The light output of the tube shall be read with a Weston Model 856 RRV photronic cell, or equivalent, provided with a Viscor filter and truncated lucite cone. The cone shall be 1.562 inches (39.67 mm) in diameter at its base, 1.125 inches (28.58 mm) in diameter at its top, and 1.6875 inches (42.86 mm) in height. The base of the cone shall be cemented to the photronic cell window. The cone top shall be in contact with the image screen of the tube. The photronic cell and cone shall be precalibrated from a diffused light source. The small end of the cone shall be placed to cover the excited area of the image screen. The conversion index is defined as:

$$CI = \frac{F1}{F2T}$$

F1 is the total available luminous flux emitted by the phosphor screen of the tube at the operating voltage specified herein.

F2 is the unfiltered flux from the 2,854°K light source incident on the photocathode of the tube.

T is the filter factor of a calibrated Corning No. 2540 (melt number 1613, .103 inch (2.61 mm) thickness) infrared filter, or equivalent, interposed between the light source and photocathode. This filter factor is the percentage of 2,854°K hololumen flux transmitted by the infrared filter and is determined by the following:

$$T = \frac{\int_0^\infty R\lambda \; J\lambda \; t\lambda \; d\lambda}{\int_0^\infty R\lambda \; J\lambda \; d\lambda}$$

Where Rλ = The relative spectral response of an EIA S-1 photosurface.

Jλ = The relative spectral distribution of the 2,854°K color temperature radiation source.

tλ = The spectral transmission of the infrared filter.

dλ = The differential of λ.

λ = The wavelength of the radiation.

TABLE I. Testing and inspection - Continued.

8/ The radiation source and filter specified in 1/ shall be used. The source shall be adjusted to produce a .500 inch (12.70 mm) diameter circle image on the center of the photocathode. The amount of radiation incident on the photocathode (prior to interposing the filter) shall be 0.0100 ± 0.0005 lumen. The 5819 or 1P21 photomultiplier tube, or equivalent, shall be placed with its cathode against the screen faceplate of the image tube. The bleeder voltage of the photomultiplier shall be adjusted to give 370 microamperes of anode current (based on an effective screen background area of 3.14 $cm^2$). The radiation from the source shall then be excluded from the photocathode and the brightness shall be read in terms of anode current (LB), of the photomultiplier tube. The ratio of conversion index to background $\left(\frac{CI}{B}\right) = \frac{1.00}{LB}$

9/ After completion of the vibration, shock, and temperature tests (when required), specified herein, the resolution pattern described on figure 2 shall be focused on the photocathode and the image of the pattern observed on the screen of the tube with a 10-power microscope. The microscope shall be aligned with the geometric axis of the tube (which shall be the center line of the 1.210 inch (30.73 mm) diameters at each end of the tube as shown on figure 1) and it shall be focused for best resolution of the test pattern image. With the microscope focused and aligned with the tube operating at normal voltage, a test spot shall then be projected on the center (tube axis) of the photocathode and the image of the spot shall be observed on the screen. The center of the test spot image shall fall on the screen within a 0.045 inch (1.14 mm) radius circle concentric with the tube axis. Following the alignment test, the position of the center of this image shall be recorded. After application of electrical shock, resulting from 10 cycles of alternate periods of 15 seconds with and 10 seconds without application of the rated tube voltage, the center of the above image shall not be displaced more than 0.0025 inch (0.06 mm) in any direction from its initially recorded position.

10/ This test shall be performed with a 10 power or greater microscopic monocular; a tungsten radiation source and infrared filter (which need not be the source and filter specified in 1/), a resolution test pattern (see 2/), and a projection lens needed to project the resolution test pattern upon the image tube's photocathode. The test pattern shall be placed between the radiation source and the filter and shall be focused on the photocathode for best equal resolution of line sets in the central area of the image tube screen. The input radiation level shall be adjusted by the operator to obtain best contrast of the resolution patterns. The image shall be considered resolved when all lines in each resolution group can be counted. The resolution test pattern shown on figure 2 shall consist of 3 groups (marked 12, 50, and 12) of lines. The center resolution group marked 50 shall have 5 sets of lines with each set having 8 black lines with a minimum length to width ratio of 15 to 1. The peripheral groups, marked 12, shall have 2 sets of lines with each set having 5 black lines with a minimum length to width ratio of 5 to 1. The width of each black line and the distance between the black lines in the group marked 50 shall be 0.01 mm. The width of each black line and the distance between the black lines in the two groups marked 12 shall be 0.04 mm. The arrangement and orientation of the groups and the sets of lines in each group shall be shown on figure 2. The resolution test pattern shall be projected 1:1 on the photocathode of the tube. (Projection other than 1:1 may be used provided the chart size is such that the projected image on the photocathode meets the above specifications.)

11/ Magnification is defined as the ratio of the separation of the two image points to the separation of corresponding object points; the latter being located on a diameter and equidistant from the tube axis. Paraxial magnification is obtained only if the object points are very close to the tube axis. Center magnification (Cmx) is a close approximation to paraxial magnification and shall be measured with a nominal chordal separation of object points of 20 ± 0.4 percent of the useful minimum cathode diameter. The object points shall be projected on the photocathode with nominal monochromatic visible light.

12/ A second magnification measurement shall be made to determine the percentage of distortion. The procedure used to determine the center magnification (see 11/) shall be used except for the spacing of the points or lines on the photocathode which shall have a separation of 80 ± 0.4 percent of the useful minimum cathode diameter. Percentage distortion shall be determined by the following formula:

$$D = \frac{M2 - M1}{M1} X\ 100$$

Where: D = Percentage distortion.

M1 = Magnification obtained in center magnification test.

M2 = Second magnification determined as above.

TABLE I. Testing and inspection - Continued.

13/ The Universal Standard Image Tube Tester Assembly F8584978, or equivalent, shall be utilized for this test. When the tube screen is observed with a 2.5 power magnifier and with no radiation incident on the photocathode, there shall be no ion spots or cold emission that appear as bright streaks or blemishes. When the screen is viewed through a 10-power microscope and with the radiation level on the photocathode adjusted to obtain best spot contrast, the opaque or dark spots shall not exceed the size and quantities specified below:

| Size of spots 1/ (Inches) | Number of spots within .300 inch (7.62 mm) diameter circle 2/ | Number of spots, within area bounded by two circles .300 inch (7.62 mm) and .570 inch (14.48 mm) in diameter 2/ |
|---|---|---|
| Greater than .012 (0.30 mm) | 0 | 0 |
| .009 to 0.012 (0.22 to 0.30 mm) | 0 | 2 |
| .006 to 0.012 (0.15 to 0.30 mm) | 0 | 12 |
| .002 to 0.012 (0.05 to 0.30 mm) | 0 | 32 |

1/ If the distance between two spots is less than the maximum dimension of either spot, they shall be considered as one spot with a size equal to the sum of the maximum dimensions of the two spots plus the amount of separation between them.
2/ The .300 inch (7.62 mm) and .570 inch (14.48 mm) circles on the image screen shall be concentric with the tube axis.

14/ Apply 13 kilovolts for 10 seconds. The tube shall be rejected for intermittent or continuous arcing, flashing, or flickering.

15/ To measure total tube dark current LIk, a microammeter shall be connected in series with the grounding terminal of the tube. This test shall be performed in an atmospheric environment of 40 to 50 percent relative humidity.

16/ The background shading shall be uniformly graded so that there is no line of demarcation between light and dark areas. Two tests shall be performed.

a. With no radiation incident on the photocathode.

b. With the radiation uniformly distributed over the photocathode produced by filtering through Corning filter No. 2540, or equivalent, 0.1 to 0.4 lumens/square foot from a tungsten source operating at a color temperature of 2,854°K.

17/ The tubes shall be rigidly mounted, singly or in groups, in a vertical position with the cathode end up, and subjected to a simple harmonic motion applied along the longitudinal axis of the tube or tubes have an amplitude of .0625 inch ± .0025 (1.59 ± 0.06 mm) (.125 ± .005 inch (3.18 ± 0.13 mm) total excursion)) at a frequency of 30 ± 2 cycles per second, for a period of 2.5 minutes. No voltage potential shall be applied to the tube during above vibration test. Any tube submitted for qualification shall be tested only once, after which a certification that the vibration test has been performed shall be issued.

18/ The tubes shall be rigidly mounted, singly or in groups, in a vertical position with the cathode end up, and subjected to a simple harmonic motion, in a vertical plane, having an amplitude of not less than .04 ± .0025 inch (1.02 ± 0.06 mm) (total excursion .08 ± .005 inch (2.03 ± 0.13 mm)) at a frequency of 50 ± 2 Hz, for a period of 2 minutes. No voltage potential shall be applied to the tube during the above vibration test. Any tube submitted for qualification shall be tested only once, after which a certification, that the vibration test has been performed, shall be issued.

TABLE I. Testing and inspection - Continued.

19/ The tube shall be placed in a test chamber and the internal temperature of the chamber raised gradually to +68°C. After not less than 1 hour at 68°C, the chamber temperature shall be lowered to +52°C and held at this temperature for not less than 1-hour. At the end of this period, the operating potential shall be applied, and the tube shall be observed for not less than 10 minutes for electrical failure or malfunctioning including blanking or flickering of the image screen or failure to fluoresce. At the end of this 10-minute period, the tube shall be removed immediately to room temperature (approximately 22°C) and shall remain at this temperature for not less than 1 hour. At the end of this period, the tube shall be examined for damage, such as, deformation, cracks, crazing, or breakage. If there is no evidence of damage, the tube shall be replaced in the test chamber and the internal temperature of the chamber lowered gradually to -54°C. After not less than 1-hour at -54°C, the internal temperature of the chamber shall be raised to -32°C and held at this temperature for not less than 1-hour. At the end of this period, the tube shall be removed immediately to room temperature and held for not less than 1 hour. At the end of this period, the tube shall be examined for damage. Evidence of electrical failure, malfunctioning, or damage shall constitute failure of this test.

20/ The following post environmental tests shall be performed and shall meet test limits specified in conformance inspection, part 1: Conversion index, conversion index to background, alignment and image shift, center resolution, cathode and screen spots, breakdown, and dark current.

21/ This test is to be performed at the conclusion of the holding period.

22/ Marginal notations are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

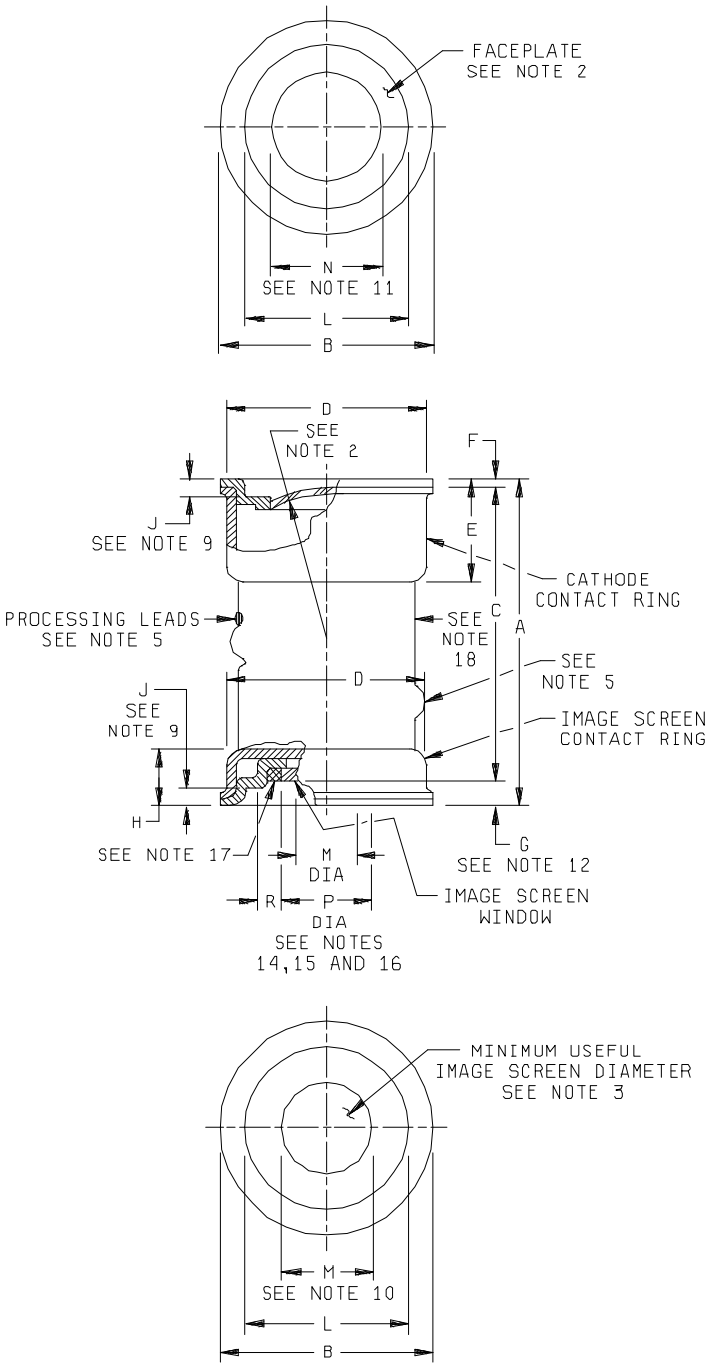


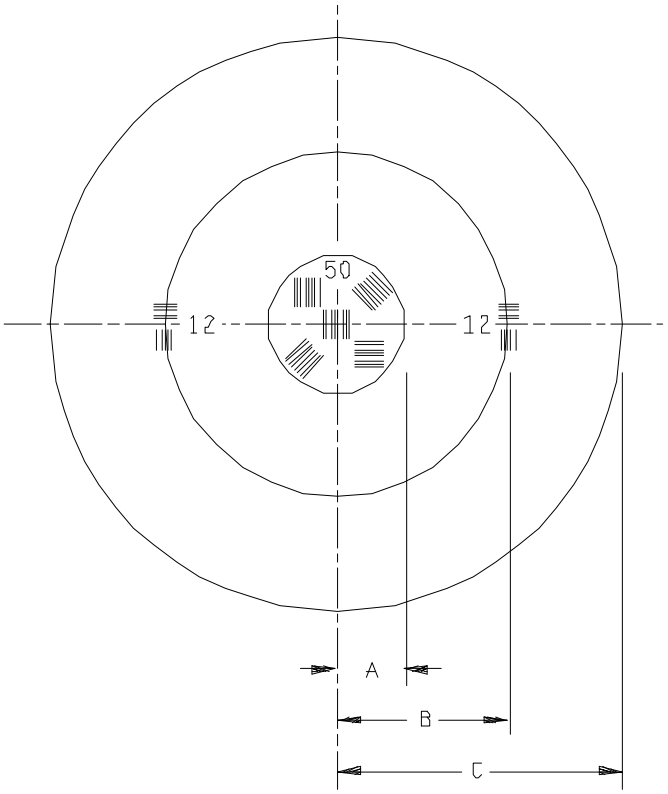

FIGURE 1. Outline drawing of electron tube type 6929.

| Ltr | Dimensions | | | |
|---|---|---|---|---|
| | Inches | | Millimeters | |
| | Min | Max | Min | Max |
| Conformance inspection, part 2 | | | | |
| A | 2.235 | 2.335 | 56.77 | 59.31 |
| B | 1.325 | 1.375 | 33.66 | 34.93 |
| C | 1.965 | 2.035 | 49.91 | 51.69 |
| F | .065 | .125 | 1.65 | 3.18 |
| G | .160 | .220 | 4.06 | 5.59 |
| L | 1.205 | 1.215 | 30.61 | 30.86 |
| Reference dimensions (see note 1) | | | | |
| D | --- | 1.315 | --- | 33.40 |
| E | .711 | .771 | 18.06 | 19.58 |
| H | .360 | .410 | 9.14 | 10.41 |
| J | .140 | .200 | 3.56 | 5.08 |
| M | .570 | --- | 14.48 | --- |
| N | .750 | --- | 19.05 | --- |
| P | .750 | --- | 19.05 | --- |
| R | --- | .350 | --- | 8.89 |

NOTES:

1. These dimensions are for information only and are not required for inspection purposes.
2. Faceplate dimensions (see note 13).
   Radius of curvature (inside and outside) shall be 1.225 inches (31.12 mm) minimum and 1.235 inches (31.37 mm) maximum.
   Thickness at center shall be .055 inch (1.40 mm) minimum and .065 inch (1.65 mm) maximum.
   Variation in edge thickness shall be .004 inch (0.10 mm) maximum.
3. Image screen dimensions (see note 13).
   Thickness at center shall be .070 inch (1.78 mm) minimum and .090 inch (2.29 mm) maximum.
   Variation in edge thickness shall be .010 inch (0.25 mm) maximum.
4. Refractive index for faceplate and image screen glass shall be $1.49 \pm .04$ inch ($37.85 \pm 1.02$ mm).
5. No part of that portion of the tube included between metal contact rings shall protrude beyond dimension B. All metal processing terminals protruding through glass envelope shall be cut off and ground flush with the glass bead. All leads and metal processing terminals shall be coated with Glyptol, or equivalent.
6. Tube axis is established by centerline through dimension L.
7. The following ratio shall govern dimensions A, C, F, and G: A minimum $\leq$ C + F + G $\leq$ A maximum.
8. All exposed metal parts shall be nickel plated.
9. Dimension J measures depth to bearing surface of metal shoulder.
10. Useful image screen diameter.
11. Useful cathode diameter.
12. Depth to outside surface of image screen window.
13. Faceplate and image screen dimensions are for guidance on component parts.
    Conformance check of these dimensions must be made prior to tube assembly.
14. Dimension G applies over dimension P only.
15. Minimum diameter of free space for external optics.
16. Within the area formed by dimension P, deviation from flatness of external surface of faceplate will not exceed .002 inch (0.51 mm) (see note 1) from peak-to-valley.
17. The shape of the image screen faceplate in the shaded area may have any configuration (for example, flat, concave, convex) but shall not extend above the bearing surface indicated by dimension J. NOTE: Associated equipment must be kept clear of this area.
18. The glass surface included between the metal contact rings shall be coated with a silicon film, Dow Corning 200, or equivalent.

FIGURE 1. Outline drawing of electron tube type 6929 - Continued.




| Letter | Inches | Millimeters |
|---|---|---|
| A | .075 | 1.91 |
| B | .187 | 4.75 |
| C | .375 | 9.53 |

NOTE: Dimensions are in inches.

FIGURE 2. Resolution pattern for tube type 6929.

Custodians:
Army - CR
Navy - EC
Air Force - 11
DLA - CC

Review activities:
Army - AR, MI
Navy - AS, CG, MC, OS
Air Force - 99

Preparing activity:
DLA - CC

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